Little Small explorers: mammals in high magnetic fields

By Amy Mast

The combination of live animals and high magnetic fields is a relatively new and unexplored realm in biology. How will animals react to the fields? What will we see and what can we learn?

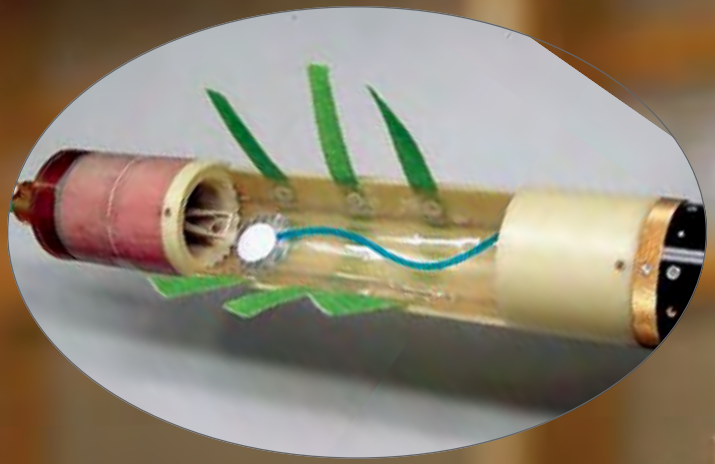
Researchers using the lab's powerful 900 megahertz superconducting magnet are taking steps toward answering these questions with a suite of experiments designed to monitor living mice, rats and birds that are sedated and placed inside the magnet. The magnet acts like the same MRI machine you'd use at the doctor's office, but because the magnetic field is so much higher, it gives researchers a far more specific, detailed look at living tissue.

These pint-sized pioneers experience magnetic fields several times higher than any human being has ever been exposed to. A typical MRI machine uses a 2-3 tesla magnet (tesla is a measure of magnetic field strength); the 900 MHz magnet reaches 21.1 tesla.

"This technology is relevant for a wide variety of research, allowing scientists to track changes in their specimens over time," FSU assistant professor and Mag Lab researcher Sam Grant explained. For scientists, this means longer experimental relationships with the same animal, and fewer animals needed to gather data – a more humane and cost-effective approach to research.

Current live animal research projects at the Magnet Lab encompass everything from the study of diseases such as cancer to the aging process. Researchers use animals to examine decay of muscle tissue caused by aging and to evaluate various treatments and exercise regimens. They evaluate effects of different treatments on cancerous tumors, study the impact of brain injuries, examine the effects of long-term exposure to high magnetic fields, and investigate the progression of neurodegenerative diseases such as Alzheimer's and Lou Gehrig's diseases.

Researchers use customized monitoring equipment, much of which is built here at the lab, that allows the heart rate, respiration, and temperature of an animal to be monitored while it is inside the magnet. It's not unlike the system used to monitor a person undergoing an operation, but it's as delicate as if it were built for a porcelain doll.



Left: Mag Lab researcher Sam Grant checks in with a massive two-year-old rat, a participant in an ongoing study on aging and muscle tissue.

Left: Mice and rats are sedated and placed in the magnet probe, which has all the comforts of a human's hospital bed.

Background: A closeup of the probe.

Little explorers: ...continued

Animals are sedated before monitoring equipment is placed on them and before they're put inside the magnet. Sedation reduces stress on the animal and allows researchers to monitor respiration, temperature, attach heart monitors and conduct imaging without interruption.

An animal placed in the magnet is removed from its habitat and placed in a separate enclosure, where it breathes in the gas that sedates it. Once sedated, it is placed inside a cylindrical probe that will go into the magnet. The animal lies on a heated pad through which warm water circulates to keep the animal at a comfortable temperature. A small pillow is placed against its body; the pressure against this pillow measures respiration. A tiny bit – like a bit for a horse – is placed in the animal's mouth, allowing a steady supply of sedating gas. The animal is then placed inside the bore at the center of the magnet.

Though the effects of high magnetic fields on living beings are not yet fully known, data so far suggests that exposure to high magnetic fields is not harmful. In-vivo research in high magnetic fields is a new and promising way to gather information about tumors, head injuries, and neurological disorders using an animal model.

Though research is largely conducted on rodents, other animals such as finches have been studied with 900 MHz magnet. The largest participant so far? Big rats. At 350 grams, rats are the biggest animals that can fit comfortably inside the magnet's central experimental space, which is roughly the diameter of a baseball.

In-house scientists and researchers from FSU's medical, human science and engineering schools glean information from animal work with the 900-MHz magnet. As with all the Magnet Lab's scientific programs, the animal program is open to users from other institutions. The Magnet Lab now offers animal storage and procedure space for visiting scientists as part of a larger lab goal to expand its biology research.

The animal storage space looks just like a boarding kennel where you would drop off a pet for the weekend, only much, much cleaner. In a room for procedures, tiny, rodent-scale exercise equipment lies in wait for the next aerobics session. Inside the housing area, mice and rats eat, sleep and play in their enclosures, seemingly unaware of how many secrets their bodies give to researchers while they're asleep.

About the 900-MHz magnet

Completed in 2005, the 900-MHz magnet, with a 105-mm bore (about four inches), is the largest magnet of its kind in the world. A superconducting magnet designed and built in Tallahassee, it stands 16 feet tall, weighs more than 15 tons, and took 13 years to complete. Its large bore allows scientists to examine larger samples and animal models, providing more information about higher order biological systems that more closely mimic human physiology. Coupled with unprecedented sensitivity and resolution, the large bore size permits for a greater range of scientific experiments. To learn more about the 900-MHz magnet and other research conducted at the Magnet Lab, visit http://www.magnet.fsu.edu/.

DID YOU KNOW?

- *Research using live animals is called in vivo, Latin for "within the living." Research on individual cells that are not part of a living creature, such as in a biopsy, is called ex vivo.*
- *Lou Gehrig's disease, one of the diseases researched in the 900 MHz magnet, is also known as amyotrophic lateral sclerosis, or ALS. It's one of the more common neuromuscular diseases in the world, and progression of the disease gradually robs the sufferer of movement. First described in 1869, it's still one of the most mysterious and difficult-to-treat diseases in the world.*
- *Although the research animals are sleeping comfortably in a temperature-controlled pod inside the magnet, the magnet itself is temperature controlled with ultra-cold liquid helium.*

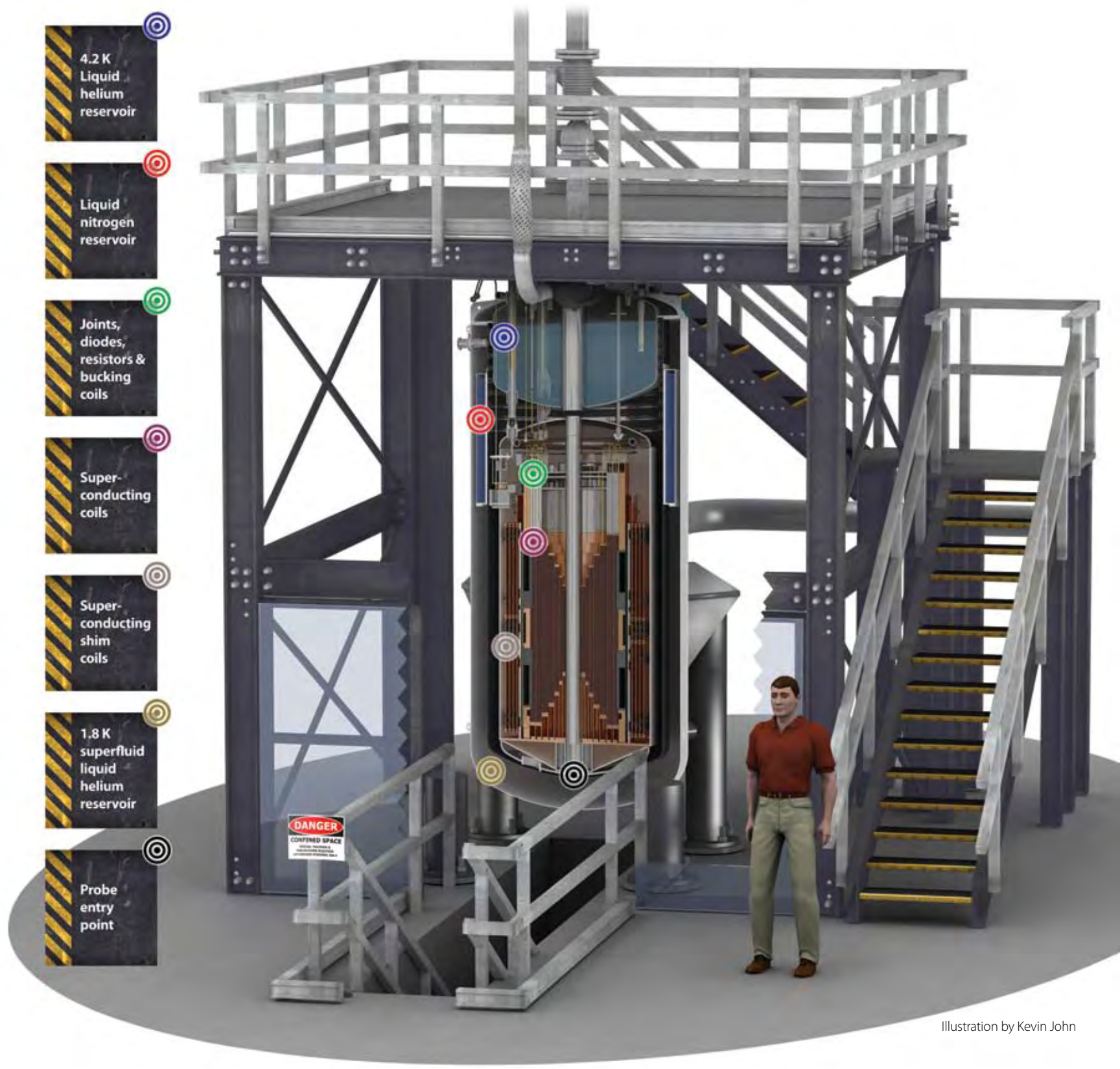


Illustration by Kevin John